The Effect of Massage on the Number and Hæmoglobin Value of the Red Blood-Cells.

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THE EFFECT OF MASSAGE ON THE NUMBER AND HÆMOGLOBIN VALUE OF THE RED BLOOD-CELLS.

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During several years past, while using massage a great deal in various diseases, I have often wished to find some additional way of accounting for the rapid improvement of color and nutrition which is seen under its application in patients anæmic from various causes, rather than the usual vague suggestion of hastened circulation and accelerated tissue change.

In pursuit of this object, in the autumn of 1893 I made some examinations of the blood of patients before and after massage. The first results were so astonishing that I reported them briefly to the College of Physicians of Philadelphia, in December last, and proceeded to a wider and more systematic study. The sum of the conclusions drawn from this extended observation is here presented.

After this investigation was begun I found a paper by Professor Winternitz,[1] which had previously escaped my notice, on the change in the number of red and white blood-corpuscles under hydrotherapeutic procedures. The article was interesting and suggestive, but did not take up the detailed examination of blood before and after massage.

In a "Preliminary Note" in the *Medical News* of December 23d, a brief account was given of a few of these studies upon the effect of massage as evidenced in the blood. The facts are so remarkable, the clinical conclusions which may be drawn from them of such widespread use and value, and the deductions which at once suggest themselves so revolutionary, so subversive of established views both in diagnosis and therapeusis, that the work has necessarily extended itself far beyond the limits originally proposed. I shall endeavor here to summarize the experiments made, to indicate the more important information acquired from them, the far-reaching possibilities which are hinted at in some of them, and the questions in the physiology and pathology of the blood which they suggest.

The cases were thirty-five in number; several of them were examined a number of times, but, in order to exclude as far as possible the element

[1] "Neue Untersuchungen ü. Blutveränderungen nach thermischen Eingriffen." Centralblatt f. inn. Medicin, 1893, No. 49.

of different individual susceptibility to the treatment, few were used more than twice. The diseases from which they were suffering included every variety of disorder affecting the integrity of the blood, except the severe acute fevers and malignant infections: simple anæmia, both slight and severe, chlorosis, anæmia from hemorrhage, from several toxic causes, from senile and other malnutritions, and at least one case in which the diagnosis of pernicious anæmia had been made by competent observers. This diagnosis was partially verified by the death of the patient without other symptoms than those of progressive anæmia,[1] although no post-mortem examination was obtained. Another case of very extreme anæmia, at first thought to be of pernicious nature, is still under observation, and at present much improved. A number of trials were also made on persons in whom there was no evident anæmia, and several on individuals in perfect health.

As will be seen from the examination of the tables, the results were uniformly upon the side of increase, except in three cases. The increase in some was very small, but the *tendency* seems always to have been in that direction. In two of the three persons whose count was lessened after massage, active exercise had been taken just previous to the count. One had walked about two miles and a half before the examination, upon a very cold day, in the teeth of the wind; the other had walked half a mile to a country station, come ten miles in the train, and then walked half a mile in town again immediately preceding the examination. In both of these there was marked diminution of the number of red globules after the application of massage, but these cases cannot be considered as contradictory of the results obtained in disease. They had already a greatly increased activity of circulation, and the rest as well as the rubbing had a share in the reduction. The third (Case VII.), by a nurse's mistake received his dinner after the completion of his massage and before the count was begun, which may have interfered with the full and usual effects of the manipulation. Previous and subsequent estimations gave decided increase.

It should be added that great care was used in ascertaining the relation to meals of the hour of examination, as it is well recognized that the corpuscles are increased during the active process of digestion, and, where the time was near a meal, the fact is mentioned in the tables.

Any efficient variety of the several types of manipulation which go under the common name of massage would produce similar if not equally marked results. In some of the cases where I did not personally oversee or direct the massage, half an hour was thought by the attendant a sufficiently prolonged application. The counts of these

[1] Dr. John H. Musser, in whose care this patient was, states that he would prefer to make a diagnosis of "severe anæmia from atrophy of the gastric mucous membrane," as the reduction of the corpuscular elements was not very great.

patients showed such small changes that inquiry was made, and afterward in the same cases a longer rubbing was used, with much more decided increase. If general massage is to be of service, it will be found that a full hour must be given to it.

A large proportion of the cases were examined by myself. The rest were divided among several observers, in order to eliminate as far as might be the element of personal error. I am especially indebted to the assistance of Dr. C. W. Burr and Dr. F. S. Pearce. The kindness of Dr. John H. Musser, Physician to the Presbyterian Hospital, allowed Dr. Pearce to examine a number of patients under Dr. Musser's care in that institution, including one in whom "pernicious anæmia" would seem a permissible diagnosis, and another (Case XXII.) which might, if judged by the blood, have been similarly classed, although there were also present severe spinal (ataxic) and hysterical symptoms, reversed and contracted color-fields, hemi-anæsthesia, etc. Several cases were counted at various times by all three of us, and Case XX. had the advantage of an examination by Dr. Frederick P. Henry, whose great experience in the study of the blood makes his confirmation of the results very valuable. I am indebted for the notes of the cases of malarial fever (Cases XXIX. and XXX.) to the politeness of Dr. John S. Billings, Jr., Resident Physician of the Johns Hopkins Hospital.

The instruments used were the Thoma-Zeiss hæmocytometer and Fleischl's hæmoglobinometer in all cases except two or three of my own, where the counts were made with the Malassez "compte-globule;" the estimates made side by side with the Malassez and Zeiss instruments were generally in remarkably close accord.

The accompanying tables explain themselves for the most part. In the first columns the "cases" and "observations" are numbered separately for convenience of reference, the age and sex are given, and a brief diagnosis; then follow the state of the red and white corpuscles and the hæmoglobin value before massage, and in the same order in the last three columns are presented the results of examination following massage. The manipulation was, except where otherwise noted, a full hour of thorough, deep general massage.

Perhaps one of the most striking results of an examination of the above figures is the large number of cases in which the count before massage far exceeded the ordinary normal standard of the text-books in the number of corpuscles in a cubic millimetre. Apparently a good many of the cases had some degree of plethora. Seventeen persons presented more than five and a half million of corpuscles, and of this number six had more than six and a half million. Yet, except two perfectly healthy individuals, there was scarcely one of these who would not have been at once described as "anæmic" if judged by the external appearance alone. It is, of course, to be said that some of them, like

Effect of Massage upon the Blood.

Case.	Observation	Age.	Sex.	Disease.	Before massage.			After massage.			Remarks.
					Red blood-corpuscles.	White blood-corpusc.	Hæmoglobin-value.	Red blood-corpuscles.	White blood-corpusc.	Hæmoglobin-value.	
I.	1	25	M.	Healthy	5,675,000	.....	110	7,950,000	.....	120	Hospital interne.
	2	...	...	Same subject	5,650,000	.....	110	8,125,000	.....	120	" "
II.	3	26	M.	Healthy	6,650,000 / 6,800,000	.....	110	5,150,000	.....	110	Count made after a sharp walk on a cold day.
III.	4	25	F.	Subacute rheumatism	7,100,000	15,000	80	8,012,500	25,000	80	Negro servant.
IV.	5	43	F.	Sciatic neuritis	6,800,000	.....	85	7,000,000	.....	85	Physician ; rest treatment for sciatica.
V.	6	45	F.	Hemiplegia (attack 18 days previous)	5,925,000	.....	64[1]	6,640,000	.....	70[1]	Half-hour's massage.
	7	...	...	Same subject	5,580,000	.....	62[1]	8,133,333	.....	70[1]	One hour's massage.
	8	...	...	" "	4,600,000	.....	74[1]	6,220,000	.....	78[1]	*See also* Obs. 50–57.
	9	...	...	" "	5,425,000	.....	.....	5,600,000	.....	.....	
	10	...	...	" "	5,012,500	12,500	65	6,675,000	12,500	75	
	11	...	...	" "	5,187,500	.....	65	8,800,000	.....	70	
VI.	12	38	F.	Neurasthenia, chronic gastritis	4,660,000	.....	.....	5,866,660	.....	.....	
VII.	13	53	M.	Hemiplegia (attack 10 weeks prev.)	5,050,250	.....	70	6,725,000	.....	75	
	14	...	...	Same subject	5,122,500	.....	65	7,240,000	.....	67	
	15	...	...	" "	5,000,000	12,500	70	4,540,000	12,500	70	By a nurse's mistake received dinner after massage and before last count was made.
VIII.	16	16	M.	Transverse myelitis (recovering)	6,900,000	.....	90	8,100,000	.....	100	Several months in hospital under massage and good diet.
IX.	17	22	M.	Locomotor ataxia (doubtful)	6,575,000	.....	110	7,340,000	.....	110	Same as above.
X.	18	16	M.	Anterior poliomyelitis (improving)	6,200,000	.....	110	7,400,000	.....	110	" "
XI.	19	37	F.	Hysterical delusions, mild melancholia.	5,400,000	.....	80	5,460,000	.....	80	Had been 4 weeks under rest, massage, and full feeding when examined.
XII.	20	40	F.	Neurasthenia	5,150,000	.....	75	5,600,000	.....	75	
XIII.	21	...	F.	"	5,150,000	.....	70	5,500,000	.....	70	Appearance highly anæmic; massage three quarters of an hour.
XIV.	22	22	F.	Simple anæmia	4,275,000	.....	70	5,450,000	.....	70	Four weeks' rest, massage, and full feeding.
XV.	23	33	F.	" "	4,550,000	.....	60	5,100,000	.....	60	
XVI.	24	30	F.	Hysterical torticollis	5,900,000	.....	75	6,750,000	.....	90	Appearance highly anæmic.
XVII.	25	25	F.	Neurasthenia, dysmenorrhœa	3,637,500	.....	55	6,025,000	.....	60	
XVIII.	26	63	M.	Convalescent from epidemic influenza.	4,550,000	.....	70	6,400,000	.....	85	Temp. before, $99^{2}/_{5}$° F. " after, $99^{4}/_{5}$° massage 70 minutes.
XIX.	27	18	F.	Hysteria, general symptoms	4,150,000	.....	90	3,300,000	.....	100	Had walked to railroad station and travelled ten miles to town immediately before count.

[1] Hæmoglobin was estimated by Gowers' instrument.

XX.	28	40	F.	Severe anæmia, January 11, 1894 .	1,650,000	.....	18	.....	.....	.....	Before all treatment.
	29	...	...	January 13, 1894 .	1,500,000	1,250	18	1,650,000	12,388	30	Blood showed, poikilocytosis, megaloblasts, microcytes, and on staining, nucleated red corpuscles.
	30	..	...	Jan. 24th, after one week's massage daily.	3,800,000	.....	35	5,400,000	.....	35	Menstruation on January 14th.
	31	...	...	Jan. 31st, no massage for four days, no medicine.	5,550,000	.....	50	.....	.....	.....	
	32	...	...	Feb. 1st, five days without treatment	5,900,000	.....	60	.....	.....	.....	The increase at this time was so great from day to day that no further counts were made.
	33	...	..	March 31st	4,800,000	.....	50	.....	.....	.....	Patient was operated for hemorrhoids, losing some blood. No treatment for 12 days after.
XXI.	34	...	F.	Severe anæmia, 8 years' duration .	1,350,000	.....	85	1,500,000	.....	90	Counted on fifteenth day from operation.
XXII.	35	50	F.	Doubtful posterior sclerosis and high-grade anæmia.							
				August 1, 1893 . .	581,000	.....	.....	.....	.....	.....	
				September 1, " . .	950,000	.....	.....	.....	.....	.....	Duodenal ulcer was suspected from pain and other symptoms; no bleeding.
				October 18, " . .	1,628,000	.....	.....	.....	.....	.....	
	36	...	...	January 16, 1894 . .	934,664	.....	15	.....	.....	.....	Poikilo-, micro-, and megalocytosis. On account
	37	...	...	January 18, " . .	825,000	.....	12	940,000	.....	12	of the suspicion of ulcer massage of the abdo-
	38	...	...	January 25, " . .	987,500	.....	22	1,450,000	.....	27	men was omitted. *See also* Obs. 62.
XXIII.	39	64	F.	Pernicious anæmia or anæmia from atrophy of gastric mucous membrane.							
				December 1st . . .	2,250,000	.....	56	.....	.....	.....	Emaciated and cachetic; too feeble for full mas-
	40	...	...	" 28th . . .	2,600,000	.....	.....	4,666,666	.....	.....	sage; rubbed thirty to thirty-five minutes.
	41	...	...	" 29th . . .	2,225,000	.....	.....	2,775,000	.....	.....	No white blood-corpuscles could be found.
	42	...	...	" 30th . . .	2,600,000	.....	.....	3,200,000	.....	.....	Patient died Dec. 31; no autopsy obtainable.
XXIV.	43	52	M.	Toxic anæmia, chron. lead-poisoning	3,725,000	.....	30	.....	.....	.....	Counted by different observers on three succes-
	44	...	...	.....	3,900,000	.....	30	.....	.....	.....	sive days at same hour.
	45	...	...	.....	4,000,000	.....	30	4,500,000	.....	30	Abdominal massage for twenty-five minutes.
	46	...	...	.....	4,000,000	.....	30	6,500,000	.....	30	General massage one hour
XXV.	47	26	M.	Toxic anæmia, chronic lead-poisoning.	5,100,000	.....	100	5,925,000	.....	100	Effleurage (forty minutes) was the only form of massage used.
XXVI.	48	40	F.	Malarial poisoning, choreic spasm of facial muscles.	4,700,000	78,333	70	7,100,000	184,210	70	White blood-corpuscles 1 : 60 before.
											" " " 1 : 38 after.
XXVII.	49	60	M.	Malarial poisoning, chronic gastritis	6,600,900	.....	80	7,050,000	.....	80	
(V.)	50	56	F.	Hemiplegia; January 12, 1894 .	5,975,000	12,500	65	6,550,000	12,500	80	At an interval of one hour after massage.
	51	...	...	January 18, " .	4,950,000	.....	65	5,250,000	.....	70	At interval of ten minutes after massage.
	52	...	...	.....	.....	.....	.....	8,912,000	.....	70	One hour and ten minutes after massage.
	53	...	...	.....	5,002,500	12,500	65	8,240,500	75,000	70	One hour's massage; first examination fifteen minutes after massage.
	54	...	...	January 25, 1894, 3 P.M. . .	.....	.....	.....	7,297,500	25,000	78	One hour and fifteen minutes after massage.
	55	...	..	" 30, " 3 P.M. . .	5,750,000	.....	67	7,975,000	.....	70	Immediately after one hour's massage.
	56	...	...	5.15 P.M. . .	.....	.....	.....	8,845,000	.....	70	One-half hour after.
	57	...	...	.....	.....	.....	.....	6,875,000	.....	70	Three hours and fifteen minutes after massage, *i. e.*, 8 P.M.; supper at 6 o'clock.
XXVIII.	58	...	...	Neurasthenia following dysentery, January 20th.	5,612,500	.....	69	8,062,500	.....	70	Dinner one hour before treatment.
				.....	.....	.....	.....				Half-hour after massage.
								5,512,500	.....	68	One and one-half hours after massage.

Case.	Observation	Age.	Sex.	Disease.	Before massage. R. B. C.	Before massage. W.B.C.	Before massage. H.	After massage. R. B. C.	After massage. W.B C.	After massage. H.	Remarks.
XXIX.	59	...	M.	Malarial fever for three months, tertian; January 1st.	2,988,000	4,500	42	.....	.....	.....	No organisms in blood at time of count; aortic insufficiency.
				January 2d . . .	3,004,000	5,000	42	3,104,000	7,500	45	
XXX.	60	19	M.	Malarial fever, paroxysm 22 hours Jan. 4th, temp. 105° F. Jan. 5th.	3,456,000	4,000	59	3,680,000	6,000	64	Had had previous attack Oct., 1893, of double tertian; counted one hour after massage.
				Quinine, gr. lx., Jan. 5th and 6th, temp. 101.5°. Jan. 6.	3,232,000	3,500	60	3,392,000	4,500	60	Many crescentic and ovoid organisms seen.

Administration of Iron.

Case.	Observation	Age.	Sex.	Disease.	Before administration of iron. R. B. C.	Before administration of iron. W.B.C.	Before administration of iron. H.	After administration of iron. R. B. C.	After administration of iron. W.B.C.	After administration of iron. H.	Remarks.
XXXI.	61	38	F.	Fat, anæmic, slight chronic gastritis	4,950,000	.....	85	6,800,000	.....	85	Fat; mucous membranes very pallid; gr. 5 iron pyrophosphate every two hours; took gr. 120 in four days, and ℥ 10 t. d. tr. ferri chloridi.
(XXII.)	62	50	F.	See Obs. 35-38	3.200,000	.....	60	4,160,000	.....	70	Patient gained greatly since last count; appearance much improved. Pyrophosphate gr. 95 in two days
XXXII.	63	20	F.	Epilepsy, minor	4,300,000	.....	50	4,600,000	.....	50	Pyrophosphate gr. 60 in thirty-six hours; appearance highly anæmic.
XXXIII.	64	28	F.	" major	4,300,000	.....	65	4,850,000	.....	70	Pyrophosphate gr. 90 in two and a half days; appearance extraordinarily anæmic.
XXXIV.	65	24	F.	Neurasthenia, dysmenorrhœa .	5,225,000	.....	85	7,000,000	.....	90	In 48 hours took pyrophosphate gr. 60 and pil. Blaud. gr.36; appearance highly anæmic.

Use of Faradism.

Case.	Observation	Age.	Sex.	Disease.	Before use of faradism. R. B. C.	Before use of faradism. W.B.C.	Before use of faradism. H.	After use of faradism. R. B. C.	After use of faradism. W.B.C.	After use of faradism. H.	Remarks.
XXXV.	66	59	M.	Hemiplegia—general senile degenerative changes.	6,215,000	12,500	.....	6,200,000	15,000	.....	Patient very weak. Slowly interrupted faradic current to all the muscles, occupying one hour.
	67	...	...	Same case	5,300,000	12,500	75	6,175,000	15,000	75	

Cases VIII., IX., and X., were under full feeding and receiving every possible tonic treatment; still, one would not ordinarily suspect a patient with anterior poliomyelitis of long standing of having over six million corpuscles and over 110 per cent. of hæmoglobin, especially one many weeks in a hospital. Still less would it generally be thought that a hospital resident physician would have such an excess of corpuscles and hæmoglobin as obtained in Case I.; the effect of a year or two's living in a hospital usually is to blanch them effectually. But all of these cases were examined more than once, and in all of them the excessive number of corpuscles was verified by the results of more than one observer. Cases VIII. and X. were both examined by Dr. Burr and by me at different times, with counts practically the same.

The next most striking fact is that, while a very large increase of corpuscles was the rule, there was in only about half the cases a decided addition to the amount of hæmoglobin after massage. In this respect the results differed very decidedly from those of Winternitz, who found an average increase of about 15 per cent. in the hæmoglobin scale after his hydrotherapeutic applications. Twenty showed an increase of 5 per cent. or over. A less difference than this cannot be accurately read on Fleischl's instrument, and although changes of less amount are noted in the table, they are for that reason not included in this summary. The discussion of these facts may be postponed for the present.

First, in examining the reason for this increase in the corpuscles, must be considered whether it is only a matter of alteration in the superficial circulation. It is hardly possible to dogmatically say it is not, since it cannot be proved, although some facts point very strongly that way. The superficial vessels are dilated by the stimulation of their muscles and nerves through massage, but the deeper ones are affected too, the alternate squeezing and relaxation by the hand-grasp acting like the heart-contraction to empty them and to encourage their rapid refilling. Nor would the supposition that the surface blood-currents are hastened serve to account for the steady, continuous, and well-maintained improvement which is had in anæmia by the use of massage, nor to explain the large increase resulting from rubbing the abdomen alone, as in Case XXIV. (Obs. 45). Of course, it may be attributed in part to the indirect effect upon the quantity of blood in the peripheral channels from the accelerated movement of the large amount of that fluid in the abdominal vessels. Yet, even if in anæmia the circulation in the peripheral vessels is insufficient, as the coldness of the extremities and the general surface pallor show, how does it come that the relative proportion of corpuscles in a given quantity of blood can be altered by massage? If it be said that it is a sufficient explanation of the improvement which results from massage, that the increase is due to the fact that before manipulation the quantity of blood in these vessels was less than

it should be and that more was brought into them by the treatment, the increase of the number of corpuscles in a cubic millimetre would still be left unaccounted for. There would be more blood in the vessels—but would there be more cells in a given quantity of it? Somehow, globules must have been called into circulation which were not previously in active movement through the body. If cells thus out of service can be induced to go upon their way through the vessels it certainly follows that an anæmia like that of Case XXVIII., and many others, is not, in the ordinary sense of the word, an anæmia at all. In Case XXVIII. before massage there were 4,500,000 corpuscles and 70 per cent. of hæmoglobin; after massage, 6,400,000 corpuscles and 85 per cent. of hæmoglobin. Corpuscles could not have been manufactured in that time to meet the demand created by an increased superficial circulation; they must have been in reserve for emergencies, or lingering, as I said in my "Preliminary Note," in the byways of the circulation, and what appeared to be an anæmia was really but a lack of activity in the corpuscles or in the circulating fluid generally. Some such explanation as that all the globules were not in use will answer for such an instance, where both the corpuscular elements and the hæmoglobin were greatly increased by massage. But the same explanation will not do for the much larger number of examples where there was a decided increase in the number of corpuscles, without like addition to the percentage of hæmoglobin. An hour's massage can scarcely cause increased production, though after repeated treatment the making of blood-cells may be stimulated; but the effect upon metabolic processes of increased activity and movement of the cells must, for the time at least, be much the same as though their number were actually as much greater as it seems to be.

Where the corpuscles are increased and the hæmoglobin remains as before, it is difficult to account for the lack of change in the amount of this substance. It may be that at any time there are a number of corpuscles carrying but little hæmoglobin, and that these are brought into action by the mechanical stimulation and general increase of the circulation. But before this happened where were they? The condition cannot be wholly due to disease, since it is present in healthy men (see Obs. 1 and 2). Did it arise only from adding to the number of red globules in the peripheral vessels at the expense of the rest of the circulation, the increase of hæmoglobin would be directly proportional to the increase of globules, but this is rarely the case In Case I., 10 per cent. represented the increased hæmoglobin value, but the corpuscular addition was almost 50 per cent. of the original amount, and nowhere have we seen the hæmoglobin rise more than 15 per cent. One conclusion must be that even in health there are vast numbers of corpuscles avail-

able for use if called for. The deductions from this fact as to diseased conditions will be spoken of later.

As was also said in the "Preliminary Note" in the *Medical News*, it is not difficult to imagine some such explanation as possible when one recalls the appearance of the bloodvessels in living tissues under the microscope. "In the lesser capillaries there appears every now and then to be a clogging, and for a time the corpuscles scarcely move. When this state is overcome in one place, a like condition is evident in another little vessel. Even in the larger channels many corpuscles seem not to share in the general movement, and to be temporarily out of the current. The white ones especially cling along the walls, and some of the red ones progress less rapidly than others, or linger for an instant, as if they were in an eddy or a side current. A portion of the blood, therefore—and, when the whole capillary system is taken into account, it must be a large portion—is not at all times in active circulation."

What we can see under the microscope is what takes place in the tiniest branches of the extreme peripheral circulation. We can scarcely suppose that in the larger channels the same phenomenon is going on upon a more extended scale, for there the stronger movement of the current would forbid it.

Hayem has said that the improvement which we desire to make in anæmia is an increase in the *active and circulating* amount of hæmoglobin. Apparently this is exactly what we do get a small degree of by this method.

Another thing very desirable to know is whether the corpuscles thus introduced into circulation are in all respects similar to the ones normally found moving in the vessels. It has seemed to me in most of the cases that there has been no decided difference between the microscopic appearance of the corpuscles before and after massage. In a few instances, and more notably in those cases which were suffering from very high grades of anæmia, like Cases XX. and XXI., it appeared to me that the number of blood plaques was greater after massage; but the former case was one in which every symptom pointed to pernicious anæmia, and, while this diagnosis is very far as yet from being borne out by the result, yet the microscopic changes in the blood were all such as we are accustomed to find in cases of advanced progressive anæmia. There were numerous corpuscles very much increased in size; there were nucleated red corpuscles; there was poikilocytosis, and in several slides, Dr. F. P. Henry, who saw this patient in consultation with me, found upon staining a few nucleated red corpuscles. The white corpuscles were enormously increased; before massage they were only 1:1200, but after massage this proportion was very greatly altered, becoming 1:134. This also was one of the cases in which a great

difference in the hæmoglobin percentage was effected. The Fleischl instrument before massage gave us between 15 and 18 per cent., and after massage over 30 per cent. My friend Dr. Judson Daland, who upon another occasion examined this patient,[1] tells me that the readings of the Fleischl hæmoglobinometer below 20 are much too low, and he has suggested a very ingenious plan for overcoming this difficulty. This same case is perhaps the one which shows most valuably the amazing effects of massage alone. The count, as will be seen from the table (Obs. 28–32), was, upon the 11th and 12th of January, 1,500,000 red corpuscles and 15 to 18 per cent. of hæmoglobin, while upon the 24th of January, the patient having in the interval had no other treatment than massage and rest in bed, without any excessive feeding, the count was 3,800,000 before and 5400,000 after manipulation. It is noticeable that in this examination the hæmoglobin was the same both before and after treatment—between 30 and 35 per cent.—and was not materially increased over the percentage upon the previous occasion, when the count had been very much lower. All treatment having been stopped from the 24th of January, the patient receiving neither medicinal nor mechanical treatment of any kind, the corpuscles nevertheless went on increasing until, on January 31st, they had reached the amazing figure of 5,550,000, with 50 per cent. of hæmoglobin. This examination was made by Dr. Burr, and the next day, February 1st, I made an estimate myself, with the result of finding 5,900,000 corpuscles and 60 per cent. of hæmoglobin.

It will be seen from the column headed "Diseases" in the table, where a brief statement of the patient's condition is given, that almost every form of anæmia and malnutrition is included, and that in all but three of the observations there was an increase in the number of corpuscles, varying from a very slight addition to over three and a half million. Nor does the increase seem to depend at all on the form of disease from which the patient was suffering. In the several healthy cases the increase was great, although the persons examined appeared to be already in a condition approaching plethora, judged by the counts alone. This was an entirely unexpected result. In slighter anæmias the improvement was very marked (Cases XIV. and XV.). In malarial anæmia, of which two decided cases are in the table (Cases XII. and XXVI.), there were like changes. In forms due to malnutrition (Cases XVI., XXXI., XXXII., and XXXIII.); in severe simple anæmia (Case XXI.); in senile degenerative changes (Cases V. and VII.); in the case of extreme anæmia from atrophy of the gastric

[1] Dr. Daland made a single estimate with the hæmatokrit, giving as a result 2,500,000 red cells. The white cells could not be properly rated owing to the presence of large numbers of microcytes, which altered the white column unduly. At the same time I made observation No. 30, which, if accurate, would show a much larger number of red globules.

mucous membrane (Case XXIII.), and in the cases of metallic poisoning, which were of the most chronic description (Cases XXIV. and XXV.), varying degrees of increase resulted.

It was not always possible to make several successive examinations at short intervals of the same patient, as the time over which this would have spread the examinations would have introduced other factors, such as an unusually prolonged abstinence from food on the part of the patient; but, in some of the cases that were counted at intervals after rubbing, the increase was found in one hour or more to be greater than in a few minutes after the completion of manipulation (Obs. 53–58).

Hæmoglobin is occasionally increased by massage, but by no means uniformly; it appears to be rather the exception than the rule to find large addition to the percentage of coloring matter. It occurred in twenty cases (omitting increases of less than 5 per cent., which are untrustworthy); but in one or two of the more severe cases (Cases XVI., XVIII., XX., and XXII.) it was very marked. The source of supply of hæmoglobin for the red corpuscles is a matter still in doubt. Judging from the frequency with which a great reduction of hæmoglobin is seen in anæmias, while the corpuscular count remains near the normal (chlorotic type), the cells in all cases of poverty of blood vary less than the hæmoglobin; they may be inaccessible to our observation; they may themselves be affected by this reduction in their hæmoglobin value, so as to make them less active, and again it may be that the hæmoglobin-production cannot be so rapidly or readily increased as the manufacture of corpuscles.

With the exception of the one patient who died during the study of the blood, by far the worst case, judged by appearance, general symptoms, length of continuance of the disease, and by blood examination, was Case XX. By an accident she was given iron for a few days, which may somewhat have interfered with the result; but other than this she had no more treatment than rest in bed, without excessive feeding, and very thorough-going daily massage; yet, with this, as I have said before, the hæmoglobin and corpuscular elements both increased with amazing rapidity and continued to increase even when all treatment was stopped, a result which sufficiently does away with any idea that the improvement in these cases is due to a temporary effect upon the superficial circulation. Here again was to be seen a disproportionate improvement in hæmoglobin and corpuscles, for when the corpuscles had reached nearly six millions, the hæmoglobin had only attained to 60 per cent.

No doubt there is another factor in these causes of improvement: the better tone of the muscles, of the heart, and of the general circulation, which is so quickly shown in such patients. Case XX. had mitral valvular disease and a consequent murmur, as well as a very loud and

clear hæmic murmur, and suffered from a general deficiency of the circulation, manifesting itself in a tendency to chilliness and coldness of the extremities. The very first hour's massage left her warm and comfortable, and its effect was felt for several hours and continued from day to day to last during a longer period each time. The organic murmur was little changed, but the hæmic murmur, which, if altered at all during the first week, was somewhat louder, has constantly lessened in intensity till now it is a very faint, soft bruit.

A few words must be said about the results of the administration of iron in large doses during a very short time. The experiments (five) were too few to be conclusive, but in all there was marked increase of the corpuscles, although the hæmoglobin made no perceptible gain. The pyrophosphate was used because of its solubility and unirritating quality. The ease with which such large quantities of iron were borne by patients with the irritable digestion of anæmia was remarkable. Probably, had the drug been longer continued the hæmoglobin would have shown more effect of it. But this and other questions relative to the effects of medicine upon the cellular production must be reserved for further study. In one case (Case XXXV.), an unfavorable subject, a trial was made of the effect of slow faradic interruptions applied to the muscles, but the result is uncertain and the case is only added for its evidence of another means of tonic treatment.

To sum up, first, the *certain results*: In health, massage increases the number of red corpuscles, and to a less degree and not so constantly their hæmoglobin value.

In all forms and grades of anæmia there is a very constant large increase in the number of red corpuscles after massage; this is greatest at an interval of about an hour, after which it slowly decreases. This decrease is postponed more and more if the manipulation be daily repeated. An improvement also takes place in the general tone of the circulatory and muscular systems.

There is an occasional but inconstant increase in the hæmoglobin value, and this increase is proportionately less great than that of the cellular elements.

It has been doubted if so powerful and fatiguing a method of treatment as massage is safe or desirable in very high grade anæmias. It is now for the first time made clear that it is of great and certain service and without danger in such cases, no matter how feeble.

It is evident, too, that our present definitions of anæmia are insufficient. An essential part of the description in all of them is that there are defects of number, of color, or of both in the blood. This is not necessarily or always true. The fault may lie in a lack of activity or of availability in the corpuscles. The state of things in the system may be, to draw an analogy from economic conditions, like the want of cir-

culating money during times of panic, when gold is hoarded and not made use of, and interference with commerce and manufactures results.

Lastly, neither an anæmic appearance nor a blood count is alone enough for a certain diagnosis. Other signs must be used as a check on the blood examination for the establishment of the existence of anæmia. For instance, many cases here recorded had full normal or even supra-normal corpuscle-count, with a good percentage of hæmoglobin. Yet they presented every external sign of poverty of blood: pallor of skin and, more important still, of mucous membranes, cold extremities, anorexia, indigestion, dyspnœa on trifling exertion. In such cases we must suppose either that the total volume of the blood is reduced, or that the usefulness of the corpuscles is in some way impaired, or that both these troubles exist together.

The white corpuscles have not received sufficient attention in this study, although it seems as if in most cases they were increased as well as the reds.

Next, as to *general conclusions*: It is possible that even in health there may be a certain varying percentage of corpuscles out of the moving current of the blood. If so, where are they, and what are they doing? We know by direct observation that all corpuscles do not travel with the same rapidity, that some loiter and delay. Our studies prove clearly enough that a great number of cells may be brought rapidly into the circulation by massage, and it seems at least probable, as Dr. Pearce has suggested to me, that those thus thrown into the current have less hæmoglobin value than the ones already in movement. This is a possible inference from the fact that corpuscular increase does not imply an addition of hæmoglobin, or at least not a proportionate addition. Have some of the globules thus cast into the hurrying stream of the blood been delaying to take up or unload their freights of coloring matter or oxygen? Do corpuscles in states of disease behave differently toward hæmoglobin, so that they absorb it less well, or transport it less successfully, or give it up with abnormal readiness? Some forms of anæmia may be due to an increased delay on the part of such cells as these, lingering sluggishly about their business, and only pushed and forced into greater activity and usefulness by the direct stimulus of massage. Whether these globules are immature ones or ones that have been made use of to the extent of their capacity also remains to be discovered.

Even when direct anæmia has been caused by hemorrhage, a part of the result may be due to the inactivity of a certain number of the corpuscles, and we may find in massage a valuable aid in the treatment of such cases, both by the impetus it will give to cells indisposed or disabled for free movement, and by stimulation of the making of corpuscles. I hope soon to publish some facts as to the application of manipulation to such disorders.

The excess in amount of blood brought into the circulation by massage may be one of the reasons why in occasional sensitive patients we see such discomforts as headaches follow its use. Practically, we have added a certain number of millions of cells to their tissues, and need not be astonished if some signs of plethora result.

It is evident that massage has complex effects and that the numerical increase of the corpuscles, the added hæmoglobin value, and the better circulatory and muscular tone, may be due to many causes operating together—a vasomotor nerve stimulation, a direct hastening of the venous currents, an indirect hastening of arterial flow, an improved metabolism, are only some of them.

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